

## Final Report

### Hard X-Ray Spectroscopy for Proton Flare Prediction

#### EOARD Contract SPC-98-4020

To: Chief of Aeronautics  
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#### Background:

The Astronomical Institute (AI) of the Academy of Sciences of the Czech Republic and the Space Environment Center (SEC), National Oceanic and Atmospheric Administration, are presently engaged in a joint venture to fly a hard X-ray spectrometer (HXRS) experiment in a space environment to demonstrate the feasibility of predicting interplanetary energetic proton events by detecting a specific genre of solar flare known to associate with these events.

The HXRS has been developed and constructed by the private firm Space Devices Ltd in Prague, Czech Republic, under the auspices and technical direction of the Principal Investigator, Dr. František Fárník. In May 1997 the HXRS experiment was manifested for flight under the Department of Defense Space Test Program (STP). The host satellite is the Department of Energy Multispectral Thermal Imager (MTI), built and subsequently to be operated by the Sandia National Laboratory (SNL). STP is providing the following funding: (1) to SNL to integrate the HXRS with the MTI spacecraft; (2) the launch to orbit; and (3) one year of on-orbit operation.

HXRS is the only guest 'piggy-back' experiment on this mission. The expected life time is three years which is expected to encompass the peak years of solar cycle 23. The scientific research leading to the implementation of this experiment was performed at SEC in cooperation with Dr. Alan Kiplinger at the University of Colorado. The preliminary design and planning for the construction of the experiment was performed at the Astronomical Institute where, also, the data received will be used for solar flare physics research. Both activities have been conducted under the Agreement between the Government of the United States and the Government of the Czech Republic for Scientific and Technical Cooperation, October 22, 1991.

In September 1998, a memorandum of Agreement between the U.S. National Oceanic and Atmospheric Administration, office of Oceans and Atmospheric Research (OAR), and the Academy of Sciences of the Czech Republic was officially approved by both institutions.

### **Experiment Situation to Date:**

Since January 1999, when the flight model of HXRS was delivered to the Ball Aerospace Corporation in Boulder (the MTI satellite manufacturer), the instrument was thoroughly tested by the group of Sandia and Ball technicians - first in Boulder and later in Sandia, New Mexico. During the tests in summer 1999, a temporary failure of HXRS was discovered and even when the failure disappeared two weeks after its appearance it was decided to bring a small team of HXRS technicians to Sandia and to discover the reason of troubles, making thus HXRS more reliable. Therefore the PI and two technicians from Space Devices visited the Sandia Laboratories in Albuquerque during October 1999 and were trying to get the instrument into the failure state. Under all the possible stresses (mechanical as well as thermal) the instrument was working well and the technicians failed to re-establish the failure state. Therefore they inspected the whole instrument as thoroughly as possible and tested it under the most severe conditions. After that the instrument was integrated with the satellite again and tested together with the satellite. All the test results were normal. Sandia technicians were then working hard to get the satellite ready for launch (scheduled for February 2000). The schedule was slightly changed twice so that the final launch date was February 28. The HXRS PI plus two technicians from Space Devices visited the base at Vandenberg to attend the launch and be ready to check the instrument health when first flight data are obtained. Unfortunately, the launch was postponed again in the last minute because of some safety issues. Nevertheless, when the last obstacle was removed, the MTI satellite was very successfully launch on March 12, 2000.

### **Financial Report:**

Since the second installment received in December 1998 the EOARD support obtained was \$6000 (second installment) plus \$3500 (third installment) which, converted into Czech crowns, represent 298066.72 CZK. As already reported in our report #2, 45000 CZK was paid in February 1999 to Space Devices for their work connected with the HXRS delivery to Ball Aerospace Company in January 1999. The remaining money was spent on the visit to the Sandia Laboratories in Albuquerque in October 1999 when the instrument had to be tested : to cover the two technicians expenses, Space Devices received 171200 CZK in total, the PI's expenses were 92064 CZK - including the car rental (the sum was covered by the remaining EOARD money, i.e. 81866 CZK plus a small addition from the Astronomical Institute). Our visit to the Vandenberg base was already paid from other resources.

### **Conclusions:**

The EOARD support helped to complete the joint space experiment - money were received in the crucial moment and we were able to deliver and test the instrument on schedule. Even when the satellite launch had to be postponed a few times the MTI host satellite was finally very successfully launched on March 12, 2000 and our HXRS instrument is in orbit. At the moment, we are waiting for the first flight data. Evaluation of the data will be the task for the US as well as Czech scientists during next 2-3 years. This task is already independent on the EOARD support which was aimed at the technical part of the project, i.e. on the completion of the instrument. Therefore we can report that this aim was very successfully accomplished.

František Fárník, Principal Investigator

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